INGESTION OF FOODSTUFFS CONTAMINATED WITH RADIOACTIVE ISOTOPES*

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THE first question is: What is our interest in the ingestion of foodstuffs contaminated with radioactive materials? The first point is that, instead of a rather generalized field of surrounding natural background of external radiation, we are taking the material into our bodies so that we are getting direct internal radiation. We are carrying this source of radiation around with us all the time, we can't shut it off, and we can't move away from it. The other important point is that, for external radiation, only the penetrating radiation, the gamma radiation, is of any importance. With the internal sources, the less penetrating radiation from alpha particles and beta particles becomes quite critical. The damage to the radium dial painters in the 1920's is considered to have come from the alpha radiation given off by the radium and its daughter products.

It should be remembered that the radioactive materials that we are taking in are chemical elements. As elements, they follow the normal processes in the body; they are metabolized in the same way, whether they are radioactive or not; and they often tend to concentrate in particular organs. For example, Dr. Eisenbud spoke about the thyroid with respect to radioactive iodine. Iodine taken into the body, whether radioactive or not, tends to concentrate largely in the thyroid. Other organs concentrate other elements, and it may very well be that the particular organ that is the site of this concentration may be rather radiosensitive. In other words, the sensitivity of various parts of the body to radiation varies greatly and the sensitive organs may concentrate radioactive elements. This is why we are interested in the ingestion of contaminated foods.

I intend to limit myself to a consideration of contamination by weapons-test material.

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In the case of weapons-test debris, we have a rather ideal scientific study; there is the most complex mixture of elements and of radioactive isotopes obtainable being distributed. In spite of this complexity, it is rather simple, in some ways, to sort out the ones of importance. The radioisotopes that are important are those that get taken up in the various portions of the food chain leading to man, that are metabolized by man, and which stay in the body for an appreciable length of time. The three that have been examined most closely are strontium-90, which resembles calcium in its metabolism and therefore is deposited in bone; cesium-137, which resembles potassium to some degree and is found in the soft tissues as well as in bone; and iodine-131, which tends to concentrate in the thyroid, but is also found in other soft tissues. These are also the radioisotopes most talked about in terms of public interest, the ones that I am sure a physician will be questioned about most frequently.

We should briefly contrast this weapons-test fallout with what might happen in a nuclear accident, in a situation in which there is a release of radioactive materials due to some plant accident. In this instance there may be a very high concentration in a very localized area, while test fallout gives widespread low-level contamination. Consider the SL-1 reactor accident that Dr. Dunham mentioned, as an example. Inside the building, the radiation levels were deadly. Outside the fenced area surrounding the building, the radiation was difficult to detect. The Windscale accident affected a larger area, but in the case of an accident we are talking about a rather acute situation, but very local. Perhaps, if everything is favorably placed, one can just walk away and wait for time and radioactive decay to take care of things. With weapons tests everyone is irradiated to some extent and it cannot be avoided by just walking away.

The way these radioisotopes get into food is important. We are speaking now of chemical elements which are coming down in fallout following weapons tests. Some of this material reaches the soil and, of course, some elements will be taken up by the plant roots, will become part of the plant tissue, and will then pass in food into animals or man, or sometimes both. There is also a portion of this material which will be deposited directly on the plant and will not go through any plant metabolic process but will, however, go on to animals or man where it may be metabolized.

The present interest, as I have said, is in the three radioisotopes, strontium-90, cesium-137 and iodine-131. And I would like to point out very briefly why we have to think of them differently. For example, radioiodine has a very short physical half-life. That is, its activity dies out very rapidly. With most foods, particularly with the frozen and canned food civilization that we are living in now, there is quite a time lag from the time they are picked or harvested until they get to the consumer. Therefore, most of the time, the radioiodine has decayed away. There isn't time for radioiodine to reach the soil, to be metabolized by the plant, and then to come to you in food. It can fall out on the plant surface and then get to you by direct ingestion of the plant in processing; however, much of the surface contamination may be washed off.

As far as the cow is concerned, she is usually out in the field when the fallout occurs. She doesn't wash the grass, she proceeds to eat it and our system of milk handling is to get it out of the cow and to the consumer as quickly as possibly. This means that milk is probably the one way in which radioiodine can get to man in any appreciable concentration. Another point to consider is that the presence of radioiodine in milk means that children get it in relatively larger quantities. Also, the child's thyroid is smaller, the radiation dose is larger, and children are presumably more radiosensitive than adults.

As to radiocesium, very little of it comes up through the soil. It happens that cesium, when it falls out, is absorbed very strongly by soils, and is not taken up very well by plants. However, there is direct contamination and, once again it is found that the route to man is very largely through the milk chain. Also, there may be quite a bit of absorption from meat because the cow has the cesium-137 in its soft tissues, which are the parts we prefer to eat. Since radiocesium is long-lived physically, it has not decayed away by the time we eat the meat. Thus, we have these two main sources of radiocesium and, to some lesser extent, the direct contamination of vegetables.

The third important radioisotope, strontium-90, has had the most public attention. In this case, the material can either fall out on the plants and give direct contamination, or it can be taken up by the plant from the soil. The important point is that radiocesium does not come to us through the soil route but only by direct contamination; if weapons tests are stopped the cesium fallout decreases rapidly. It is not taken up from the soil appreciably, and therefore the accumulated cesium contamination of the soil is not a problem. On the other hand, strontium-90 is taken up through the soil route and accumulated deposit on the ground makes it a continuing source of intake.

Unfortunately, here again one of the major sources of human intake is milk. It turns out that in the average diet about half of the strontium-90 that we take in comes from milk. Milk, as we are speaking of it, includes the milk in all the foods that are eaten. About one-fourth of the strontium-90 comes in through grain, and another fourth through vegetables. So it turns out that if we decide to change our diet and not drink any milk, the difference in intake of strontium-90 would be rather negligible.

For the last point: What is being done about the situation? I think a lot of work is being done, as Dr. Dunham has mentioned, on reaching a better understanding of what is going on in the physical aspects of fallout, on metabolism and on radiation effects. And, as Dr. Chadwick has mentioned, a great deal of effort is going into determining standards or permissible levels. Of course, the other approach is removal of these radioisotopes from foods. The one success, to date, is a joint effort by the Departments of Agriculture, of Health, Education and Welfare, and the AEC, on removal of strontium-90 from milk. With the current levels of contamination, removal is not economically sound. At some point, if contamination should continue at a very high rate, we might have to decide that it is worthwhile to decontaminate the milk. At the present time, I think that the panel agrees that there is not much point to it.

MODERATOR CHADWICK: Dr. Harley has raised the question of what to do about ingestion of radioactive materials and has mentioned the removal of strontium-90 from milk. I'd just like to comment on how one decides when to do something about it. As we indicated earlier, one presumably bases a conclusion of this general sort on a decision that the benefit and risk are out of balance.

When considering the development of radiation protection standards for radioactive materials in the environment, one is generally talking about restricting the release of radioactive materials from the source —atomic energy industries, for example. Balancing benefit and risk is a matter of deciding whether the atomic energy industries can cut down the amount of radioactivity they release, and still be able to conduct their operations so that we continue to get benefits from such industries.

Now, in the case of radioactive materials already in the environment the problem is quite different and a different kind of balance has to be made. In this situation the balance is between the risk of a particular measure to cut down radioactivity intake as against the risk of the amount of radiation exposure that the population would receive otherwise. Let us look specifically at the removal of strontium-90 from milk. As soon as we influence the economics of milk, presumably, we would influence milk consumption, because these are inevitably related. People do continue to buy milk, no matter how expensive it becomes. When we talk about the economics of milk, we must talk also about raising the cost and thus, reducing consumption. We would then have to balance the possible health impact of a reduction in milk consumption against the health effect from the radioactivity in the milk. At the moment, we do not expect to see levels of radioactivity in the environment which would produce a great enough risk to justify any of the countermeasures that we know about now. We are working on this matter of countermeasures to find out whether there may be others that could be applied a great deal more easily.

Now, we turn to medical exposure. Dr. Eisenbud has described this as being one of the largest man-made sources and the one source presumably which can be reduced. Dr. Norman Simon will discuss with us the exposure of patient and physician by diagnostic and therapeutic devices.